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Recommended Dietary Allowances Rev. 1953

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Recommended Dietary Allowances

Revised 1953

A Report of the
Food and Nutrition
Board

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RECOMMENDED DIETARY ALLOWANCES

Revised 1953

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RECOMMENDED DIETARY ALLOWANCES

for the maintenance of good nutrition in healthy persons in the United States of America

Revised 1953

THE MEANING AND THE APPLICABILITY OF THE RECOMMENDED DIETARY ALLOWANCES

Numerous dietary standards have been formulated by national and international groups for use in planning and evaluating diets and food supplies for individuals and population groups. These standards have varied in philosophy and objective and consequently in specific recommendations. Many of the earlier standards suggested minimal requirements of nutrients recognized to be necessary for the prevention of nutritional deficiencies among average individuals of a selected population. In 1940, when the Food and Nutrition Board accepted responsibility for developing a dietary standard for the United States, it seemed preferable to formulate nutrient allowances suitable for the maintenance of good nutrition in essentially the total population rather than those allowances which would fulfill minimal needs of the average person. In developing its recommended dietary allowances the Food and Nutrition Board has relied on published evidence relating to requirements for the various dietary essentials, plus the combined judgment of a large number of nutrition authorities, particularly those actively engaged in research. Recommended allowances for calories and for a number of essential nutrients were adopted by the Board in 1941 and published in bulletin form in 1943.[8] The allowances were revised in 1945[9] and again in 1948.[10]

Much information relative to nutritive requirements has accumulated in the last five years, and the recommended allowances have again been examined in the light of the currently available evidence. Also, since the last revision, dietary standards have been formulated for Canada[4] and Great Britain,[3] and the report of the Committee on Calorie Requirements of the Food and Agriculture Organization of the United Nations[5] has been published.

The term "Recommended Allowances" was chosen by the Food and Nutrition Board in 1941 to avoid any implication of finality of standards or of minimal or optimal requirements. The values proposed represent exactly what is implied in the literal interpretation of the words "recommended dietary allowances," i.e., levels of nutrient intake appearing desirable for use in planning diets and food supplies. This same general principle or objective is reaffirmed in the present revision.

The allowances are designed for the maintenance of good nutrition of healthy persons in the United States under present conditions. They are not necessarily applicable to situations of stringency or limited food supply. The recommendations are not requirements, since they represent, not merely minimal needs of average persons, but nutrient levels selected to cover individual variations in a substantial majority of the population. In addition, the values for each nutrient above the minimal level which will prevent deficiency are considered to provide

for increased needs in times of stress and to permit other potential benefits. Although the optimal intake of essential dietary constituents remains largely speculative, there is considerable evidence that improvement in growth and function occurs when the intake of certain nutrients is increased above the level just sufficient to prevent signs of deficiency disease. The nutritive intakes recommended are, in general, higher than average requirements and lower than the amounts which may be needed in pathologic states or in rehabilitation following depletion. The margin between "minimal requirements" and "recommended allowances" varies among the essential nutrients. Reasons for this include variation in the body's capacity for storage, the extent of variations in individual needs, and differing margins between minimal and optimal, or between optimal and excessive, intake for certain nutrients.

As previously noted, the allowances are tentative and approximate values, formulated for guidance rather than detailed application. When applied to individuals or groups, they must be judged by the effects on the persons involved. The recommendations are not designed to provide a basis for judging the nutritional status of population groups but rather to serve as a guide for planning food supplies for these groups. If these allowances are used in dietary evaluation, it is essential to appreciate that, while most persons whose consumption equals or exceeds the goals are presumably adequately nourished, not all persons who fail to reach these goals are malnourished.

The dietary standards proposed by the Committee on Nutrition of the British Medical Association[3] are somewhat similar in philosophy and objective to the Recommended Dietary Allowances, but the caloric estimates and quantities of various nutrients recommended "are believed to be sufficient to establish and maintain a good nutritional state in *representative individuals* of population groups." The British standard thus differs in providing values which apply to the average person rather than values which will cover essentially all individuals, recognizing, however, that some members in every group may need more than the average.

The dietary standard proposed by the Canadian Council on Nutrition[4] differs considerably in purpose and philosophy from the American and British recommendations. The Canadian standard represents "a nutritional floor beneath which maintenance of the health of the people cannot be assumed." It is designed not only as a basis for planning food supplies for individuals or groups, but also for use in assessing the amount of each nutrient provided by a diet for an individual or group in terms of *probable physiologic requirement.* Recommendations are based upon body size, and the influence of work on requirements is emphasized.

In view of the differences in underlying philosophy and purpose between the Canadian, British, and American standards, it is obvious that specific recommendations will differ. Values proposed in the Canadian standard approach minimal requirements; allowances in the British standard are for maintenance of good nutrition in the average person; allowances in the United States standard are recommended for the maintenance of good nutrition in substantially all normal persons.

The Recommended Dietary Allowances can be attained with a good variety of common foods which will also provide other minerals and vitamins for which requirements are less well known. The bases upon which the recommendations were formulated are summarized in the sections which follow.

SCIENTIFIC BASES FOR THE RECOMMENDED DIETARY ALLOWANCES

Calories

Since the 1948 revision of the Recommended Dietary Allowances, calorie standards have been published by the Canadian Council on Nutrition[4] and the Food and Agriculture Organization of the United Nations.[5] As a basic calculation, the Canadian standard provides calories for adult maintenance *at rest* equal to 93 ($W_{kg}^{.75}$). The corresponding FAO calculation provides calories equal to 92 ($W_{kg}^{.73}$) for men and 82.5 ($W_{kg}^{.73}$) for women. The added calorie requirements for degrees of activity are provided, in the Canadian standards, on the basis of descriptive work loads and, in the FAO requirements, by a reference level of activity described for a standard man and a standard woman. The FAO system takes account of age (including the age of adults), sex, and climate.

Heretofore, the Recommended Dietary Allowances have specified three categories of activity for a 70-kilogram man and a 56-kilogram woman, with due recognition of the fallibilities of the allowances as applied to individuals. The principles still adhered to are (1) that calorie allowances must be adjusted up or down to meet specific needs, and (2) that the proper calorie allowance for an individual is that which over an extended period will maintain body weight or rate of growth at the level most conducive to well-being.

In view of the observation that the FAO system has been generally satisfactory in many parts of the world, the system, with two modifications, has been adopted for this revision of the Recommended Dietary Allowances. The tabulated adult allowances for calories and other nutrients are adjusted to three ages for men and women, replacing the former three activity catgories.

The basis of the recommendations is the calorie allowance for a "standard" man and woman, both aged 25, living in a temperate climate (mean annual external temperature 10° C.), and weighing 65 and 55 kilograms, respectively. These standard persons are presumed to be fairly active physically, being neither sedentary nor engaged in hard physical labor as a major occupation. The man could be employed in light industrial work; he could be a delivery man, a painter, an outdoor salesman, or a farmer except in the periods of heaviest farm work. The woman could be employed at bench work in a factory; she could be a shop saleswoman, or an active homemaker and mother. Both man and woman are presumed to engage in a moderate amount of outdoor recreation and to lead a vigorous healthy life. The allowances of 3200 and 2300 calories, respectively, appear to be satisfactory for this "standard" man and "standard" woman. Adjustments on the basis of the described characteristics for age, body size, climate, and activity will be indicated when individuals or population averages differ from the standard man and woman.

Adjustment of calories for age. At older ages, the FAO report suggests that allowances be reduced by 7.5 per cent for each decade of age beyond 25. The actual change with age would apparently more nearly be met with a reduction of approximately 5 per cent for each decade after age 25. For ages 20 through 24 an *upward* correction of 0.5 per cent per year may be made.

Adjustment of calories for body size. For men and women differing from the standard body sizes of 65 and 55 kilograms (143 and 121 lbs.), the following formulas are applicable:

$$\text{Cal. for men} = 152\ (W^{.73})$$
$$\text{Cal. for women} = 123.4\ (W^{.73})$$

where W = body weight in kilograms. For example, allowances for 25-year-old men weighing 50, 60, 70, and 80 kilograms, respectively, would be 2600, 3000, 3400, and 3700 calories. Women of the same age and weighing 40, 50, 60, and 70 kilograms would receive, respectively, 1800, 2100, 2400, and 2700 calories. Adjustment by pounds to other body sizes may be facilitated by the following table:

APPROXIMATE WEIGHTS CORRESPONDING TO SPECIFIED PERCENTAGES OF THE CALORIE ALLOWANCES FOR THE STANDARD MAN AND WOMAN

Weight in Pounds		Per Cent of
Men	Women	Standard Allowance
105	90	80
124	104	90
143	121	100
163	135	110
183	156	120

In the use of this table, it should be observed that if a 143-pound man at 35 years of age is considered to require 3000 calories, then a man of the same age weighing 105 pounds, but otherwise comparable, would require 80 per cent of 3000, or 2400 calories. And if a 121-pound woman at 35 years of age is estimated to need 2200 calories, then a 156-pound woman, otherwise comparable, would need 120 per cent of 2200, or 2600 calories. (Both of these examples assume that the given weights are desirable with respect to height and health.)

Actual versus desirable body weight. Final body length (height) is usually attained by age 20 or shortly thereafter, but in the United States the average person tends to continue increasing body weight until close to 60 years of age. The 67-inch man who weighs 145 pounds at age 25 approaches a weight of 160 pounds 30 years later, and the woman who weighs 121 pounds at age 25 tends to gain some 17 pounds by age 55. Life insurance and other data indicate that these weight gains are undesirable and that the most favorable health expectation is associated with no rise in weight beyond that normally pertaining to age 25 or 30. In recommending calorie allowances for adults, it appears proper to make the calorie allowance, not on the basis of actual body weight, but according to the proper body weight. The following table may be used as a guide for this purpose. The weights and heights recorded include ordinary indoor clothing and shoes with one-inch heels. The same values will apply roughly for nude weights and heights.

Desirable Weights for Height

(Modified from Metropolitan Life Insurance Company Statistical Bulletin 23, 1942; 24, 1943. Age is disregarded because weight gains beyond the ages of 25 to 30 years are considered undesirable.)

Height, Inches	Weight in Pounds	
	Men	Women
58	—	112±11
60	125±13	116±12
62	130±13	121±12
64	135±14	128±13
66	142±14	135±14
68	150±15	142±14
70	158±16	150±15
72	167±17	158±16
74	178±18	—

Adjustment of calories for climate. For climate, a 5 per cent increase or decrease in calorie allowance for every 10° C. difference (decrease or increase) in mean external temperature from the reference base of 10° C. is proposed. These adjustments are devised specifically for application to differences in mean *annual* temperature, but they may well serve for the adjustment to seasonal differences as well. In various parts of the United States the *difference* in mean winter and summer temperatures may vary between 10° C. and 30° C. This would indicate corrections from 5 to 15 per cent in the calorie allowances (i.e., increase in winter, decrease in summer), according to the conditions. It should be observed that all adjustments for climate presuppose an ordinary amount of actual exposure to the climate. For persons spending most of their time out of doors, these adjustments may be insufficient, particularly during winter in the Northern and Central States. It is obvious that people who spend almost all their time in well-heated buildings during the winter will not need the extra food calories required by individuals less sheltered at this time of the year.

For practical guidance in the matter of calorie adjustment to climate, it may be observed that Boston, Cleveland, Chicago, Omaha, Denver, Detroit, Spokane, Salt Lake City, and Santa Fe, New Mexico, correspond closely to the 10° C. mean annual standard. For places like Minneapolis and Burlington, Vermont, the annual calorie allowance may be 2 per cent higher. A reduction of 5 per cent for the year would be appropriate for most parts of the Southern and Southwestern States and Southern California, including such cities as Jacksonville, Phoenix, New Orleans, and Galveston. A reduction of 8 per cent would be proper for Puerto Rico.

Adjustment of calories for pregnancy and lactation. Beyond any adjustments for age, body size, and climate, special calorie allowances are needed for pregnancy and lactation. Since the energy costs of pregnancy and lactation are not particularly related to the factors already mentioned, the recommended allowances can be adjusted by simple additions to the allowance for the nonpregnant, nonlactating woman. The suitability of the total allowance for the individual woman

should be checked from time to time by a qualified physician, nurse, or nutritionist.

For pregnant women, an extra allowance of 400 calories daily is suggested for the third trimester. For the earlier part of pregnancy, the calorie cost of pregnancy is probably small and tends to be compensated by a small decrease in physical activity. For many American women, the reduction in physical activity in the third trimester may compensate for the extra demands for calories from the fetus, making an increased calorie supply in the woman's diet unnecessary. Observation of the body weight will enable the physician to give the proper advice to the individual. A gradual, controlled gain of body weight up to about 22 pounds seems to be desirable for the woman who is initially at ideal weight for her height. A smaller gain is desirable for the obese woman; a larger gain may be best for the unduly thin woman.

For lactating women, the calorie allowance, to be precise, should be adjusted to the average milk yield, but an allowance of 1000 calories daily is proper for an average production of 850 milliliters of milk with an energy value of about 600 calories. For the individual, the calorie supply should be adjusted to the actual milk production, perhaps averaged on a weekly basis. The calorie supplement for lactation should be about 130 calories per 100 milliliters of milk.

Calorie allowances for children and adolescents. For infants and children, two modifications are introduced in classification. In the previously published recommendations, allowances for infants have been based on the average infant at 6 to 8 months of age. Encouragement is given in this revision to adjustment of calorie and protein allowances according to size, activity, and rate of growth by specifying three periods. The age groupings of 1 to 3 months, 4 to 9 months, and 10 to 12 months are, of course, arbitrary and should be interpreted judiciously. The allowance of 120 calories per kilogram for 1 to 3 months, 110 calories per kilogram for 4 to 9 months, and 100 calories per kilogram for 10 to 12 months reflects the general pattern of intake observed for infants not breast fed. The underweight infant may benefit from a larger allowance if it is well taken. The specified allowances would be provided by approximately 850 milliliters of human milk for the 1- to 3-month period and by approximately 1400 milliliters for the period 4 to 9 months.

For children, there was previously no distinction made between sexes until 13 years of age. However, in the United States there appears to be an appreciably greater energy requirement for boys than for girls of the 10- to 12-year age group. Not only do the boys engage in more energetic games, but they also seem to expend more energy than girls of the same age and body weight in the same activities.[12] Consequently, for the 10- to 12-year-old children the calorie allowances have been specified as 2500 for boys and 2300 for girls, although the allowances for specific nutrients are not changed significantly.

The problem of providing the proper calorie allowance for adolescents is difficult to solve satisfactorily. To adjust the calorie allowance to the actual body size might penalize the underfed child who could use more, not less, food than the overfed youngster. On the other hand, at ages 16 to 20 the final body size is being approached, and body size cannot be totally disregarded. The FAO system provides a rational solution which, however, is not always easily applied to individuals: "It is recommended that the requirements of adolescents be ad-

justed according to the body size to be reached at maturity and that requirements at age 16 to 19 years, inclusive, be assessed as approximately 120 per cent and 105 per cent of requirements at 25 years for males and females, respectively." In essence this means that a boy of 16 who might be expected to attain a weight of 65 kilograms at age 25 would receive 3800 calories regardless of his current body weight. But a boy of 18 weighing 70 kilograms and tall in proportion might be expected to have a proper weight of 80 kilograms at age 25 and should receive 4500 calories.

The calorie allowances cited here for infants and children, as for adults, are not proposed to be more than rough guides for groups and are still less applicable in detail to individuals. The rate of growth, the appetite, and the actual fatness of body indicated by the subcutaneous fat should be observed and used as better guides to calorie needs than any arbitrary allowances.

Adjustment of calories for activity. The outstanding factor causing variability in calorie needs is physical activity, and no simple scheme can be devised to evaluate this for either children or adults. Earlier tables which sought to assess calorie requirements according to occupation no longer suffice in the day of the 40-hour work week and the wide-spread introduction of tools and power to save energy both on and off the job. Increasingly, the modern American tends to expend most of his energy away from the job. He (or she) may spend, per week, 40 hours at work, 20 hours eating and going to and from work, and 50 to 60 hours in sleep, but there are still 50 to 60 hours for energy expenditure at high or low rate as the case may be.

The standard activity of the standard man and woman was specified to correspond roughly to the general average of the population, and the figures of 3200 and 2300 calories, respectively, were selected to provide for the needs, at the specified age (25 years), body weight (65 and 55 kilograms, or 143 and 121 pounds), and climate, for this level of physical activity. For more extensive physical activity, the calorie allowances recommended in this revision should be increased by perhaps a maximum of 50 per cent for the heaviest type of work. This maximum, amounting to a total of 4800 calories for the 65-kilogram standard man, is rarely encountered and, when it is, usually represents a temporary need. The usual upper level for men and women at heavy work will more likely be 20 to 25 per cent above the standard level, that is about 3800 to 4000 calories for men and 2800 to 2900 for women (age 25, weights 65 and 55 kilograms).

For truly sedentary people, on the other hand, the standard calorie allowances must be reduced, the lower limits being about 2500 and 1800 calories for the 25-year-old men and women of standard size. Lower values will apply to persons who are confined to room rest or are similarly greatly restricted in physical activity. In general such persons will be under medical care, and the calorie allowance should be reviewed frequently. Other things being equal, the lowest level of calorie allowance for extremely sedentary subjects and invalids who do not need to gain weight should represent about 1.2 times the basal metabolism as ordinarily measured. But, in these as in all other categories, the calorie allowance should be adjusted to the individual's needs as indicated by weight, weight change, and clinical status.

Protein

The protein allowances recommended for normal adults, regardless of muscular activity but not including pregnancy or lactation, are based on the standard of one gram of protein per day for each kilogram of body weight. This value has been considered to be in reasonable accord with the principles of the recommended dietary allowances. Its original basis was the average amount of protein required for equilibrium in more than 100 nitrogen-balance experiments in the course of 25 independent investigations, including work in several countries and with both sexes.[27] This average was increased to cover individual variations in protein requirement of normal people and differences in the nutritive quality of mixed-protein diets. The recommended allowances thus arrived at by the Board in 1941 are again reaffirmed. The actual figures recorded in the table are somewhat lower than in the 1948 revision[25] because of the acceptance of a smaller standard man and woman, in accordance with FAO recommendations for calorie requirements. Increased calorie expenditure due to activity does not increase protein requirement, provided the calorie requirement is satisfied. The recommended allowances for proteins assume adequate caloric intakes.

The nutritive value of proteins is primarily dependent on the amino acid composition,[18] and the lower biological value of vegetable proteins as compared with animal proteins is well known. The inclusion of a variety of foods, and especially products of animal origin, in the diet assures a satisfactory amino acid distribution as well as sources of other nutrients.

The essential amino acids for adult males consuming a very simplified diet have been identified and tentative figures for "recommended" intakes presented by Rose.[26] By personal communication Dr. Rose has explained that his values represent about twice the highest observed minimum requirements for maintenance of nitrogen equilibrium in young adult males. His values quoted below are therefore to be regarded as safe allowances and not necessarily optimum. The "recommended" amino acid intakes in grams per day were as follows: isoleucine, 1.4; leucine, 2.2; lysine, 1.6; methionine, 2.2; phenylalanine, 2.2; threonine, 1.0; tryptophan, 0.5, and valine, 1.6. Recent evidence (Rose, unpublished) indicates that 80 to 85 per cent of the methionine requirement is replaceable by cystine and 70 to 75 per cent of the phenylalanine requirement is replaceable by tyrosine. These intakes of amino acids are easily supplied by mixed diets.

There is abundant evidence available to show that nitrogen equilibrium may be maintained upon levels of protein much below the present recommendations.[19, 23, 27] However, the estimation of requirements by balance methods has certain limitations. The bare maintenance of positive balance is possible at any level above the minimum requirement, the maintenance of nitrogen equilibrium in adults is not necessarily the desired objective, and the optimum level of positive balance is difficult to assess. Methods for evaluation of the effects of different levels of proteins need further study.

It may be noted that the recommendations are for normal healthy adults. Large protein losses occur after injury and must be replaced during recovery. Protein needs during tissue repair are high, as they are during any growth process.

The protein allowances for pregnancy and lactation are based on the observations of Macy and her coworkers, [24] Coons, [21] and others. These investigators showed that growth of the fetus and adnexa in pregnancy, and the demands for

milk production in lactation, greatly increase the protein needs over those of the nonpregnant state. Assuming a woman adequately nourished prior to pregnancy, the increased need begins in the latter half of pregnancy and is greatest when lactation has reached its maximum. The values in the table should be adjusted as the requirement varies with size.

The protein requirement for infants is difficult to specify. During the first month of life desirable allowances are dependent upon maturation of excretory and endocrine functions and no specific recommendations are given. The breast-fed infant normally receives from 2 to 2½ grams of protein per kilogram of body weight per day. This is less than the amount which has been recommended[25] and the amounts supplied by most formulas for artificial feeding. The limited evidence available indicates that, with improved processing techniques for increasing digestibility, the utilization of proteins from cow's milk is similar to that of the proteins from breast milk; that feeding higher levels of protein than are supplied by breast feeding will increase the amount of nitrogen retained,[22] and that nitrogen retention is apparently not maximum in the breast-fed infant.[28] However, there appears to be no convincing evidence either that the breast-fed infant is lacking in protein or that the higher level supplied by many conventional formulas should be decreased. Adequate data are not yet available on the performance of artificially fed infants receiving protein levels comparable to those obtained in breast feeding. Thus, while the protein allowance for artificially fed infants may well be overly generous, no change is made for the present in the previous recommendation of 3.5 grams per kilogram of body weight per day.

The recommendations for children after infancy are based upon balance studies as found in the literature. These data indicate that the protein need per kilogram decreases from 2.5-3 grams in early childhood to 1.5-2 grams in late childhood and adolescence, to approximately 1 gram for adults. The values in the table approximate these amounts. It should be noted that these generalizations should not obscure the fact that protein requirements are relatively high for the periods of rapid growth and lower during periods of slow growth. The time of these growth phases varies among individuals. Recent wide-spread interest in protein deficiency syndromes such as Kwashiorkor disease[20] emphasizes the particular vulnerability of children who receive diets in which the protein content is low and primarily of vegetable origin, even when the total calorie intake is adequate or high.

Calcium

Since the 1948 revision of the recommended allowances, many studies have been published on calcium balances of adults under varying dietary conditions.[29, 46] In children, balance data can be interpreted in relation to growth and development of ossification centers; in adults, calcium balances cannot be interpreted without qualification because there are no precise criteria for evaluating the role of dietary calcium in maintaining the well-being of the adult. The decision to recommend an allowance of 800 milligrams per day (table) for adults was made after due consideration of the available balance data and of the metabolic and dietary factors which pertain to the utilization of calcium. The basic assumption for this recommendation was that the adult calcium allowance (ex-

cluding pregnancy and lactation) should provide for calcium equilibrium throughout adulthood, but the desirability of continued calcium storage after completion of growth is a matter of conjecture.

In regard to the calcium balance studies, certain observations may help to delineate the problem of interpretation of the data which have been reported: (a) The calcium balance tends to reflect the previous dietary intake of calcium, and the capacity of adaptation to lowered intakes is evident. Adaptation may require a few days or many months.[46] (b) As calcium intake increases, fecal calcium increases proportionately more than does urinary calcium; urinary calcium excretion tends to increase in older individuals.[40] (c) Calcium balances in adults appear to reflect intermittent losses and gains of calcium which tend to occur in cycles. Wide variations among individuals prevail, suggesting metabolic differences not explained by intake or absorption. (d) Calcium losses through the skin have not been taken into account.[39, 45] (e) Many aged animals and humans are prone to negative calcium balances. [30, 34, 42, 48] Limited evidence would suggest that negative balances in adults may be the result of persistent low intakes[30, 52] and dietary intake can reverse the negative balance.[30, 34, 48] This is not confirmed in studies on rats.[38]

Studies reviewed by Cobb[34] suggest that wide variations in mineralization of the adult skeleton are to be expected. In general, the weight of the skeleton appears to increase through age 35, to decrease gradually with yearly variations until about 65, and then to decrease progressively during advanced ages. Most of the data concerning the skeletal development before 30 years of age have been based on X-ray studies of selected cases known to be in a good state of nutriture, while information on older persons has been based largely upon skeletons of unclaimed bodies whose nutritional history was unknown. The variability of mineralization observed in the younger group, known to be well nourished, was small, but variability increased rapidly in the subjects over 30 years of age.

The relation of calcium intake to osteoporosis in elderly people has not been established. The decalcification of the skeleton is influenced by the generalized atrophy in aging[52] and the failure of the protein matrix in which the calcium is deposited.[31] Lessened activity and endocrine balance are also factors in the loss of calcium in the adult.[46] Such aging changes do not occur abruptly, and simultaneous anabolic metabolism of bone persists in advanced aging.[30, 31]

The possibilities of excessive dietary calcium intakes are remote. Dietary calcium appears not to be a primary factor in calcification of soft tissue.[31] .Kidney stones have been reported only under conditions of immobilization,[31] hypervitaminosis D,[32, 36] endocrine dysfunction, or specific bone disease.[31]

The metabolism of calcium is known to be influenced in children by vitamin D. There is limited evidence of the need for vitamin D by the adult, other than that derived from ordinary exposure to sunlight, except in pregnancy and lactation.[32, 37, 44] However, the seasonal variation in available sunshine in the North Central area as compared with the Southwest should not be ignored and most of the published studies have been from the North Central area. The blood calcium of the healthy adult is remarkably constant and remains so even with severe osteoporosis.[52]

Sherman[49] demonstrated that increased intakes of calcium not only increased the length and density of the adult rat skeleton but also increased the life span

and delayed the onset of degenerative changes. Liu and McCay[42] have reported that the apparent requirement of aged dogs for calcium is greater than that of young adult animals. Henry and Kon[38] reported that rats "adapted" to a low calcium diet were better able to store calcium than those "adapted" to a high calcium diet, and negative balances after complete calcification were probably due to adaptation. The extent to which these observations can be applied to man is questionable. On the other hand, Stearns[51] found that adolescent girls who were well nourished stored amounts of calcium predicted for rate of growth, but undernourished girls required several months of refeeding before they reached the same efficiency in utilization of the mineral.

Review of the calcium allowances for growth resulted in only one change from the previous recommended allowances for children. Because of ability to use increased calcium in late adolescence, shown by girls as well as boys, [29, 46] the allowance for 16- to 20-year-old girls was increased to 1.3 grams per day. In evaluating calcium allowances for children, special consideration was given to the studies by Daniels[35] and by Outhouse[47] of preschool children, by Macy[43] of children 5 to 12 years of age, and by Wang[53] of adolescent girls. The earlier studies by Sherman and Hawley[50] and by Wang and coworkers[54] were also evaluated, as were the calculations made by Leitch[41] as to the probable requirements during the period of growth. These studies and calculations have been checked against the recently published paper of Stearns.[51] It would appear that previously determined allowances are adequate for good growth and development. Undernourished children may require special treatment.

The allowances for pregnancy and lactation are intended to provide for the growth of the fetus and for milk production. These needs are indicated by the observations of Macy and coworkers, Coons, and others.[33, 44] It should be emphasized that the limitation of increases in the dietary to the last trimester of pregnancy assumes a well-nourished woman at the onset of pregnancy. Where there has been previous undernutrition, increased intake of calcium should be supplied earlier.

Iron

The recommended allowances for iron were originally based to a large extent on the suggestion of Sherman[73] that 12 milligrams is a desirable level of intake for adults. The mean intake of 8 milligrams required by his subjects for equilibrium was increased by 50 per cent to provide for individual variation. There is considerable evidence, especially the observations of McCance and Widdowson,[66] of Hahn,[59] and of others, that adult males can be maintained for periods of time with very low intakes of iron.

The more recent investigations of Moore and Dubach[69] indicate that the absorption of iron from food may differ from its absorption when administered in the form of ferrous salts. These workers incorporated radioactive iron into eggs, chicken muscle, chicken and rabbit liver, mustard greens, and spinach. The efficiency of absorption by healthy adults and patients with anemia was then determined. Fourteen of the sixteen healthy subjects absorbed less than 10 per cent of the iron from these foodstuffs, and iron-deficient patients were no more efficient in absorbing food iron. These studies were interpreted as supporting the reasonableness of the recommended allowances for this element.

The possible effect on iron requirements of dermal excretion[61, 67, 68] has been considered, but unexplained discrepancies in the reported estimates do not indicate that the existing allowances should be altered on the basis of these findings.

Leverton[64] showed that young women were in equilibrium with an intake of approximately 7 milligrams daily. In a later study[65] she found a larger amount to be needed unless the diet contains all other dietary essentials abundantly. The recommended allowance of 12 milligrams for women becomes justified, for iron, like calcium, is poorly utilized by many persons.

The demands of pregnancy have been estimated[56] to require an increase of about 3 milligrams over the normal requirement. This amount was therefore added to the 12-milligram allowance assigned to the nonpregnant woman. The data of Hahn and associates[60] indicate that this increment is more important during the last half of pregnancy. McCance and Widdowson found good hemoglobin levels in pregnant women with this intake. Although no evidence exists that the need for iron is materially increased in lactation, since milk contains little, it seemed wise to retain the same allowance during lactation as for pregnancy.

Studies of the iron requirement for children have been reported for infancy and the preschool years. Stearns and Stinger[74] and Oldham, Schlutz, and Morse[70] showed that for infants 0.5 milligrams for each kilogram of body weight is close to the minimum needed to maintain a positive balance and a good hemoglobin level. From a critical appraisal of the results of Rose,[72] Leichsenring and Flor,[63] Ascham,[55] Daniels,[57] and Porter[71] in studies of preschool children, it was concluded that the need can be met by 0.3 to 0.4 milligrams for each kilogram of body weight. The allowances for the preschool years were obtained by using these values in relation to the weights at the different ages.

For the child of early school age, 7 to 11 years, the allowances recommended are supported by the observations of Johnston,[62] who found that children of these ages could maintain normal hemoglobin levels with an intake of 0.35 milligrams for each kilogram, or a daily total of 9 to 10 milligrams; larger amounts were ineffective. Darby and coworkers[58] studied the iron absorption with radioactive iron in school children 7 to 10 years of age. The iron intakes, estimated from diet records, averaged about 12 milligrams daily. The hemoglobin levels appeared normal for the age. When 2- or 3-milligram doses of iron containing the tracer were fed, from 10 to 16 per cent of the iron reappeared in the circulating red cells. This level is higher than would be expected in nondeficient, nonpregnant adults and the increased absorption was attributed to the demands of growth. A daily allowance of 10 milligrams appears to be reasonable for this age group.

No data were found for iron requirements during adolescence. The allowances recommended were estimated on the assumption that needs are greater than those of the adult.

Vitamin A

A new international standard for vitamin A was established in 1949 by the Subcommittee on Fat-Soluble Vitamins of the World Health Organization.[86] The new standard defines the International Unit as equal to 0.344 micrograms of vitamin A acetate or 0.30 micrograms of the alcohol and makes 0.6 micrograms of beta-carotene the unit for the provitamin.

The diet of man affords sources of vitamin A both as the preformed vitamin and as the provitamin, carotene. In the average American diet it is estimated

that two-thirds of the vitamin A activity is derived from carotene and related compounds, while one-third is ingested as the preformed vitamin. The biologic availability of carotene may vary with the dietary source and is conditioned by the presence of other substances in the diet.[75] Recently accumulated evidence demonstrates that carotene is converted into vitamin A in the intestinal wall.[78] In depletion, vitamin A disappears from the intestine long before significant changes have occurred in liver reserves. When depleted animals are fed carotene, vitamin A is again demonstrated in the intestinal wall. It is the esterified form of vitamin A which is found in the intestine regardless of whether carotene, vitamin A alcohol, or ester is administered.

There are differences in availability of the various forms of vitamin A in humans. Week and Sevigne[83] found that the increase in the serum content of the vitamin was greater after administration of vitamin A alcohol, as compared with the acetate and the natural esters of the vitamin. The various forms were all better utilized and stored when fed with corn oil as compared with ethyl laurate and mineral oil. Mineral oil effectively reduced absorption of each form.[84]

The Medical Research Council of Great Britain has reported the results of wartime experiments attempting to induce vitamin A deficiency in human subjects.[80] It is suggested in this report that 2500 I.U. (750 micrograms) of vitamin A or 3000 I.U. (1800 micrograms) of beta-carotene in oily solution will meet minimal adult requirements and provide a margin of safety. It is also stated that 7500 I.U. of carotene would probably be required if green vegetables were to provide the sole source. The subjects in these experiments were adults. Whether the results would have been the same with children cannot be stated. However, it has been found in animal experiments that deficiency signs occur sooner, advance more rapidly, and are more severe in immature than in mature animals, although requirements for vitamin A on the per weight basis are approximately the same in all groups. The Canadian Council on Nutrition, in reviewing the literature, found that an intake of 4 micrograms of vitamin A per kilogram of body weight was needed in man and in various other species of mammals to protect them against deficiency.[77] This figure was arrived at on the basis of a standard designating 0.22 micrograms of pure vitamin A as equivalent to 1 I.U. and would be 6 micrograms per kilogram of body weight in terms of the new international standard.

There is evidence that dividends in health and more effective physiologic function may accrue when quantities of vitamin A are allowed which are in excess of those required to prevent signs and symptoms of deficiency. By supplying rats from five to ten times the amount of vitamin which prevented deficiency, Sherman and his associates[81, 82] observed that the life span was prolonged, the rate of weight gain increased, and reproductive functions improved.

The requirement for vitamin A appears to be proportional to body weight and quantitatively similar in all animals studied, including man.[76, 79, 85] Levels of intake which provide 20 I.U. (6 micrograms) of preformed vitamin A per kilogram of body weight, or 40 I.U. (24 micrograms) of beta-carotene have been demonstrated to meet minimal requirements. The allowances recommended do not differ from those in earlier editions of Recommended Daily Dietary Allowances. Each allowance has been calculated on the basis of an intake approximately double that meeting minimal requirements, and assuming a diet of natural foods contributing two-thirds of the total vitamin A activity as carotene and

one-third as the preformed vitamin. The allowance for the reference man, therefore, is 5000 I.U. as provided by 4000 I.U. of carotene and 1000 I.U. of vitamin A. Six thousand I.U. or 3600 micrograms of beta-carotene would meet this allowance totally. If the sole source were preformed vitamin A, 3000 I.U. or 900 micrograms would be needed. The added allowances for children and for women during the third trimester of pregnancy and lactation are retained as in earlier statements of the Food and Nutrition Board.

The Board recognizes that allowances for this vitamin cannot at this time be stated precisely. Those recorded are proximate levels of intake which, in the opinion of the referees, are adequate to meet the needs of health. It will be possible to state requirements more exactly only when further information has accrued concerning the relationships between concentration as determined chemically and biologic activity of the vitamin and its precursors in various foods. The variation in availability of the carotenoids in food which relates to other constituents of the diet is recognized. It is considered likely that a diet adequate in content of other essential nutrients and containing a variety of natural foods will allow for most effective utilization of the vitamin A activity of that diet.

Thiamine

For practical purposes it seems best to continue to consider the thiamine requirement in terms of total calories of the diet. In the original table the thiamine allowances for the several categories were based upon the concept that a definite ratio exists between calories and thiamine throughout the entire caloric range. The chief changes in the 1945 revisions were based on the consensus of opinion that the proportion of thiamine required decreases as the caloric expenditure increases above the basal levels. This concept is retained. The present recommended allowance of 0.5 milligrams per 1000 calories for energy needs of less than 3000 calories is similar to those previously recommended, with minor alterations to correlate the data with the revised table of caloric requirements. For each additional 1000 calories needed above the 3000-calorie level, 0.2 milligrams of thiamine may be sufficient. When intakes are reduced below 2000 calories, the thiamine allowance should not be less than 1 milligram daily.

Studies on the minimum thiamine requirement of adults by Elsom,[87] Williams,[102] and Oldham,[99] and their associates were interpreted by these workers as indicating that the minimum requirement was between 0.35 milligrams and 0.5 milligrams per 1000 calories. Other investigators[93, 95, 98] have reported that the minimum requirement is 0.23 milligrams or less for each 1000 calories. Horwitt and associates[93] observed only minimal signs of inadequacy when a diet containing 0.4 milligrams of thiamine per day (0.18 milligrams per 1000 calories) was fed to 12 male adults for a period of 3 years. Ten other subjects receiving 0.2. milligrams per day (0.09 milligrams per 1000 calories) within 3 months showed an abnormal increase in the levels of lactic and pyruvic acid in the blood after glucose administration and a standard exercise test. Subsequently, incontrovertible clinical signs of thiamine deficiency were observed, which were completely repaired by thiamine administration. These studies served to corroborate the reports of Keys and associates,[95] and Najjar and Holt[98] and agreed quite well with Holt's[91] reinterpretation of the earlier work of other investigators, in which he estimated that the minimum thiamine requirement was something more than 0.17 milligrams per 1000 calories.

Thiamine requirements may be estimated from the amounts of thiamine excreted in the urine. Levels of 50 micrograms of thiamine excreted in 24 hours were associated with only minimal pathology during more than 2 years on a diet of 0.18 milligrams per 1000 calories.[93] Urinary excretion of 100 micrograms per day has been considered as the nutritional borderline by most workers. Urinary excretions greater than 100 micrograms per day were obtained by Hathaway and Strom[90] on an intake of 0.37 milligrams per 1000 calories, by Melnick[97] and by Foltz and associates[88] on an intake of 0.35 milligrams per 1000 calories, and by Glickman and coworkers[89] on an intake of 0.4 milligrams per 1000 calories.

On the basis of the evidence reviewed, including diet studies of population groups, the minimal requirement for adults may be considered to be approximately 0.23 milligrams for each 1000 calories. It is recognized that requirements vary with different persons and with the amount of carbohydrate in the diet. The recommended allowance must be sufficient to meet these varying needs. Thiamine is one of the several nutrients of which body stores are never large and are exhausted early by febrile and other diseases, surgical operation, and other stresses. Inasmuch as normal persons at any time may be forced to meet such stresses, it is desirable that stores of thiamine be maintained. In view of these considerations, the recommended thiamine allowance provides 0.5 milligrams for each 1000 calories for adults on ordinary levels of calorie intake, but the thiamine intake should not fall below 1 milligram daily.

The thiamine requirement of the infant has been studied in relation to the thiamine content of human milk by Knott and coworkers,[96] who suggested 30 micrograms for each kilogram of body weight as the minimum requirement. At six months of age this would approximate 0.27 milligrams for each 1000 calories. The average content of human milk is about 0.15 milligrams per liter, or 0.21 milligrams per 1000 calories. Similarly, the average whole milk dilution formula for infants does not contain more than 0.24 milligrams for each 1000 calories; because of the heat treatment it receives, it may be less by 20 per cent or more. Infants receiving these levels do not show evidence of deficiency. Holt and associates[92] have estimated the thiamine requirement of 7 normal infants by means of a urinary excretion procedure as being between 0.14 milligrams and 0.20 milligrams per day. It appears that the minimum requirement for the infant in relation to calories is similar to that of the adult, and it is assumed that the same values would prevail through the various ages of childhood and adolescence, thus supporting the recommended allowance of 0.5 milligrams of thiamine per 1000 calories.

Few data have been found relating to the requirement during pregnancy. Oldham and coworkers[100] studied women during the last five months of pregnancy. With an intake of 1.0 milligrams the urinary excretion was 200 micrograms, indicating that this amount is sufficient and that the thiamine requirement in proportion to calories is the same in pregnancy as in other categories. On the other hand, Toverud[101] reports that in Norway during the war period, when the population was regimented as to diet, pregnant and nonpregnant women had much the same diet except that 750 cc. of milk was allotted to pregnant women. The nonpregnant women had small excretions of thiamine, whereas the pregnant women had little or none and, in many instances, developed symptoms of thiamine

deficiency. These findings suggest that the need for thiamine is increased during pregnancy.

The thiamine requirement during lactation has been found to be between 1.1 and 1.23 milligrams daily.[94] The recommended allowance is set at 1.5 milligrams daily.

Riboflavin

Investigations of riboflavin requirement in man have indicated that clinical evidence of deficiency occurs when the intake is less than 0.6 milligrams daily in an adult.[109, 116] Studies of urinary excretion have suggested that an intake of 1.1 to 1.6 milligrams daily will provide adequate body stores.[103, 108, 114] In several species of animals and in man, ingestion of 15 to 20 micrograms of riboflavin per kilogram of body weight daily has been shown to prevent deficiency.

The assessment of riboflavin requirements by means of depletion studies in man has emphasized the fact that the appearance of specific lesions will vary with the individual and his environmental stresses[109] and that the absence of such lesions does not necessarily imply riboflavin adequacy. Skin lesions, such as angular stomatitis and scrotal dermatitis, become apparent when the riboflavin intake is somewhat below 0.75 milligrams per day. Sebrell and his associates[116] found that within three to eight months a group of women who received 0.5 milligrams of riboflavin per day developed distinctive signs of ariboflavinosis. Horwitt, Hills, and coworkers[105, 109] noted lesions within four to ten months in a group of 15 men on a diet which provided 0.55 milligrams of riboflavin. Three of these men developed relatively severe dermatological lesions, 9 showed milder symptoms usually restricted to scrotal dermatitis, and 3 others had no symptoms at all.

Lesions attributable to riboflavin deficiency have not been noted at levels of riboflavin intake above 0.75 milligrams per day. Keys and coworkers[111] observed no physical or functional deterioration in a group of active young men who were supplied with approximately 1.0 milligrams of riboflavin daily for nearly six months. Williams and associates[117] found no apparent deficiency in 4 female subjects maintained for nine months on a diet which provided 0.8 to 0.9 milligrams. Horwitt, Liebert, and associates[110] fed a similar diet which provided between 0.8 and 0.9 milligrams per day to a group of 22 men for over two years, and only one subject showed any signs of physical deterioration that might be attributable to lack of riboflavin.

Since the absence of dermal lesions cannot be used as proof of adequate nutrition, there have been numerous attempts to evaluate the supply of riboflavin in the tissues by comparing the amount excreted with the amount administered. Comparative studies by Horwitt, Harvey, and their coworkers[108] on the amounts of riboflavin excreted in the urine at different levels of intake have shown that a tissue reserve of riboflavin may not be maintained in adult men at levels of intake below 1.1 milligrams per day. When intake is restricted to levels between 0.55 and 1.1 milligrams per day, less than 10 per cent of the ingested riboflavin was excreted in the urine. At levels of 1.6 milligrams and higher, more than 25 per cent was excreted. In another study[107] with an intake of 0.5 milligrams, 4 per cent was excreted in the urine, and when the intake was increased to 1.3 milligrams for two months, 21 per cent was excreted on the average.

Davis, Oldham, and Roberts[104] have conducted urinary excretion studies on

women to show that the tissue requirements of healthy young women can be met by an intake of approximately 1.0 milligrams of riboflavin. Brewer and coworkers[103] have interpreted their data on urinary excretion to show that tissue reserves of riboflavin in women may be maintained by levels of intake of 1.3 to 1.5 milligrams per day.

The requirement of riboflavin appears not to be related to calorie requirement or to muscular activity. Although a direct relationship between riboflavin and protein requirements has not been established, the riboflavin allowances recommended are computed from the protein allowances, using a factor of 0.025. This takes advantage of the similar conditions which increase the need for riboflavin and protein simultaneously, such as growth, body weight increase, pregnancy, lactation, etc. The values thus computed are not appreciably different in most of the categories from those recommended in 1948.[112] The apparent decrease in the amounts recommended for adults results from the smaller "reference man" and "reference woman" used in the present tables. In individuals above average in size, the riboflavin allowance may be increased by adding 0.025 milligrams per kilogram above the reference body weight. The amounts recommended for pregnancy and lactation in this revision are somewhat lower than those proposed previously, but they are consistent with recent interpretations of the needs of these groups as reported by Oldham, Sheft, and Porter,[113] and Roderuck, Coryell, Williams, and Macy.[115]

The riboflavin allowances for infants, computed from protein allowances, are increased appreciably over the 1948 recommendation. Holt[106] estimates the minimum requirement to be between 0.4 and 0.5 milligrams daily. Although the recommended levels for infants exceed the riboflavin likely to be taken in by infants on human milk only, the adequacy of human milk in this respect is not questioned. Cow's milk contains more than three times as much riboflavin as human milk, but the relative utilization is not known.

Niacin (Nicotinic Acid)

When the original table of allowances was formulated, no data on niacin experiments with human subjects were available, but calculations from experiments on dogs indicated that the niacin allowances were approximately 10 times the thiamine allowances.

In 1946, Frazier and Friedemann[123] recalculated, on the basis of more recent data, the protein, thiamine, riboflavin, and niacin content of pellagra-producing and pellagra-preventing diets and concluded that the minimum daily intake of niacin in a marginal diet containing corn products is about 7.5 milligrams per day. These authors also pointed out that the milk diets used by Goldberger for the prevention of pellagra supplied about 5 milligrams of niacin per day. It is now well established that the anti-pellagra value of diets high in milk is related to the tryptophan supplied by the milk proteins.

In the rat, niacin is an essential nutrient only when the tryptophan content of the diet is low.[129, 130] Under these conditions[131] the niacin requirement is approximately 10 times the thiamine need. The high incidence of pellagra when the human diet is rich in corn and low in animal protein is undoubtedly due, not only to the low amount of niacin in corn, but also to the fact that the main corn protein, zein, is very low in tryptophan. Sarett and Goldsmith[134, 136] have shown

that the administration of L-tryptophan to normal human subjects leads to an increased excretion of N^1-methylnicotinamide, the pyridone of N^1-methylnicotinamide, and quinolinic acid. Other compounds were detected when DL-tryptophan was given, or when L-tryptophan was given to pellagrins. Several investigators have reported healing of the lesions of pellagra upon administration of tryptophan.[118, 134, 138] Apparently the rat and chick readily convert tryptophan to niacin compounds, while the monkey[137] carries on this process very ineffectively. The dog seems to be intermediate in this metabolic activity. In humans, there is some evidence for a conversion ratio similar to that of the monkey.[125, 126]

Some of the niacin requirement may be obtained through bacterial synthesis in the intestinal tract. Ellinger and Benesch[122] found a decrease in the urinary elimination of the end products of niacin metabolism in human subjects given succinyl sulfathiazole. Denko and coworkers[121] measured the excretion of several B vitamins by normal subjects on a restricted intake and found that the total excretion of niacin in the urine and feces was approximately equal to the intake but did not show the large excess observed with biotin and folic acid. Benesch[119] has also demonstrated that anaerobic organisms may actually destroy niacin produced by aerobic organisms. Lyman and Elvehjem[133] working with rats on low tryptophan diets found a lower niacin requirement when dextrin was used as the carbohydrate than when sucrose was used, but on the dextrin diets the synthesis was never sufficient to meet the entire requirement. Sarrett[135] has recently concluded that the intestinal flora in man may furnish only small amounts of niacin above that provided by the diet.

Goldsmith and associates[126] produced typical lesions of pellagra in each of 3 adult females who were maintained for more than 50 days on "corn" diets which furnished about 2000 calories and approximately 190 milligrams of tryptophan and 4.7 milligrams of niacin per day. In one subject who received the same diet supplemented with 2 milligrams of niacinamide daily for 122 days, no clinical evidence of niacin deficiency was observed. Of three subjects receiving a wheat diet furnishing 200 milligrams of tryptophan and 5 milligrams of niacin daily for more than 90 days,[125] characteristic signs of niacin deficiency appeared in one subject, evidence suggestive of deficiency in a second, none in the third. One subject received a wheat diet containing 230 milligrams of tryptophan and 5.7 milligrams of niacin for 95 days without developing signs of deficiency. These findings suggest that the niacin requirement is in the neighborhood of 6 to 7 milligrams daily when the intake of tryptophan is about 200 milligrams and that requirement may be slightly higher on diets containing corn products. It may be that some of the niacin in corn is unavailable to the organism, as suggested by recent studies with rats.[128, 132] Horwitt[127] reports from experiments conducted at the Elgin State Hospital that no obvious signs of deficiency were observed in subjects receiving diets containing less niacin and tryptophan, and no more thiamine or riboflavin, than was in the Goldberger Prison Diet.[124] The Elgin diets furnished about 2300 calories, 5.8 milligrams niacin, and 265 milligrams tryptophan daily and were supplemented with pyridoxine, pantothenic acid, vitamin B_{12}, folic acid, biotin, and vitamins A, D, and C, while the Goldberger diets were not so supplemented. The Goldberger diet furnished 3000 calories daily and contained corn meal. There was no corn meal in the Elgin diets, although zein was included to lower the relative lysine and tryptophan content of the basal diet.

Goldsmith and associates[125] measured the urinary excretion of niacin metabolites in subjects receiving "corn" diets (furnishing 200 milligrams tryptophan) with added increments of niacinamide. The proportion of niacin metabolites excreted increased when the level of niacin intake reached 8 to 10 milligrams daily. Below this level, excretion of niacin metabolites was about 0.2 milligrams per milligram of niacin intake. When the diet contained more than 8 to 10 milligrams of niacin, the excretion rate was approximately 0.6 milligrams of niacin metabolites per milligram of intake. This difference in excretion rate is significant. These findings suggest that, with a corn diet which furnishes 200 milligrams of tryptophan, body stores of niacin are adequate when niacin intake is 8 to 10 milligrams daily.

Daum and associates[120] have recently reported the thiamine and niacin intake for 10 healthy young males. The daily average intakes were 1.97 milligrams for thiamine and 16.25 milligrams for niacin.

The recommended allowances for niacin in the 1948 revision are ten times the thiamine allowances. From the data given above, these allowances appear to provide more than the average needs that may occur in any population group. No difficulty should be encountered with levels of intake lower than these if an adequate supply of good protein is included in the diet.

It is apparent that niacin requirements can be established only in relation to intake of tryptophan, since this amino acid functions as a precursor of niacin. Until the amino acid content of diets is more accurately established, it would seem wise to retain the present recommendations.

Vitamin C (Ascorbic Acid)

The recommendations given in the table for vitamin C (ascorbic acid) are based upon (a) intakes known to protect against severe or mild signs and symptoms of scurvy, for individuals ranging in age from infancy to maturity; (b) the quantity supplied to infants by human milk when the mother's intake of vitamin C is characteristic of good diets; (c) human and animal intakes that maintain specific functions such as wound healing, enzyme activity, cellular proliferation, and resistance to common stresses; (d) variations in tissue concentration that result from different intakes, and related observations of the risks of tissue injury or functional disturbance; and (e) comparative studies in nutrition, including animals that require vitamin C for protection from scurvy (guinea pigs and primates) and animals that maintain a "normal" concentration of the vitamin by tissue synthesis.

Numerous observations indicate the critical levels of intake that are necessary to afford protection from gross signs of scurvy through a period of several months in infants, children, and adults.[144, 148, 149] These levels are approximately one-seventh to one-third of the values given in the table. There is evidence, however, that such intakes may not be satisfactory for the preservation of optimum health through long periods of time or when the body is subjected to common forms of stress.[140, 142, 146, 147] Considerable difference of opinion exists regarding intakes that may be regarded as satisfactory. Interpretations are especially varied in relation to the concentrations of ascorbic acid in the plasma, white blood cells, and glandular tissues that should be accepted as "optimal."

The values given in the table represent an appraisal of all the evidence available.

They are not "saturation" values, since more generous intakes result in distinctly higher concentrations in the tissues.[143] The recommended allowances do permit tissue storage within the range found to be approximately normal for the tissues of animals in which the vitamin is under physiological control, and in human tissues when there is a nominal intake of antiscorbutic foods.

The concentration (and distribution) of ascorbic acid in human tissues, from infancy to old age, is roughly comparable to the concentrations observed in the tissues of nearly all experimental animals under normal conditions.[139, 141, 150]

There is no evidence of ascorbic acid synthesis in human or guinea pig tissue. A progressive depletion can be observed in guinea pigs, in man, and in other primates when there is a deficient intake; but when the intake is at a satisfactory level, the tissue concentrations rise approximately to those observed in animals in which the vitamin is maintained under physiological control by tissue synthesis. In guinea pigs, for example, although 0.5 milligrams per day will protect young growing animals against the classical signs of scurvy, distinct gains in health have been demonstrated at intakes up to about 5 milligrams per day.[142, 146, 148, 149]

The daily intake of an infant receiving normal human milk is approximately 30 milligrams.[145] This amount permits the maintenance of tissue and plasma concentrations in a range that is characteristic of nearly all well-nourished animals that have been studied. The intakes recommended for older age groups have a similar relationship to body storage except that the tissue concentrations tend to be moderately lower with increasing age. The ratio between the intakes recommended for infants and for adults corresponds with the approximate ratios recorded in the table for thiamine, riboflavin, vitamin A, and niacin.

Vitamin D

The vitamin D requirement has been studied more extensively for infancy than for any other age period. Many of the studies have been concerned with the amount of vitamin D necessary to prevent rickets. Such studies are not particularly useful in determining a recommended allowance, since an amount greater than that which just prevents rickets produces greater calcium retention and more rapid growth. Evidence exists[154, 155] that from 300 to 400 units daily commonly permits maximum retention of calcium in infancy when the calcium intake is satisfactory. Maximum calcium retention is associated with excellent skeletal growth and early dentition.[159] Larger amounts of vitamin D do not increase calcium retention or the rates of growth and dentition.[156]

A general opinion exists that babies born prematurely require more vitamin D than do babies born at term and it is a common custom to give more. No evidence exists that a larger amount is needed. Rickets, to which the prematurely born infant is especially susceptible, is most often due to deficiency of intake of calcium and phosphorus rather than to a greater need for vitamin D. Few reports have been found concerning the minimum requirement of prematurely born infants for vitamin D. McQuarrie and coworkers[158] found that 540 units daily would prevent rickets. Smaller amounts were not tried except in one case in which 300 units daily was sufficient. Glaser and associates[152] found that as little as 100 units daily prevented rickets and permitted normal growth. Calcium retention was found to be as good with 200 units daily as with 400 or 800 units. Harrison and associates found biochemical evidence of vitamin D deficiency after 6 to 8 weeks

of age in premature infants given vitamin-D-free feedings. These changes could be prevented by 250 units of vitamin D daily, and feeding of 500 units was no more effective than the smaller dose.[153] Because of the poorer utilization of fat by the prematurely born baby, the use of a water-miscible preparation of vitamin D may be considered advisable.

Evidence is good that vitamin D is needed throughout the growth period,[155] but the actual requirement has not been determined accurately. It is known, however, that 400 units daily is ample for good calcium retention in children when the milk intake is appropriate.[155] A few children do not require a supplement of vitamin D for good calcium retention, but the majority do. In adolescence, however, the evidence indicates that the need for vitamin D is as universal and as great as in infancy.[157] The total amount required in adolescence probably is no greater than in infancy.

The need for supplemental vitamin D by vigorous adults leading a normal life seems to be minimal. For persons working at night and for nuns and others whose habits shield them from the sunlight, as well as for elderly persons, the ingestion of small amounts of vitamin D is desirable. When adults are receiving only small amounts of calcium, ingestion of vitamin D does not increase the utilization of that which is ingested, nor does vitamin D decrease the requirement for calcium.[151]

During pregnancy and lactation the calcium and phosphorus requirements are greatly increased. Supplemental vitamin D increases the utilization of these elements. The optimum amount of vitamin D is not known, but retention values obtained by some investigators with high dosages of vitamin D seem no greater than those with moderate dosage. On the basis of available evidence, 400 units is probably adequate.

FOOD AND NUTRITION BOARD, NATIONAL RESEARCH COUNCIL
RECOMMENDED DAILY DIETARY ALLOWANCES[1], REVISED 1953

DESIGNED FOR THE MAINTENANCE OF GOOD NUTRITION OF HEALTHY PERSONS IN THE U.S.A.

(Allowances are considered to apply to persons normally vigorous and living in temperate climate)

	Age Years	Weight kg. (lb.)	Height cm. (in.)	Calories	Protein gm.	Calcium gm.	Iron mg.	Vitamin A I.U.	Thiamine mg.	Ribo-flavin mg.	Niacin mg.	Ascorbic Acid mg.	Vitamin D I.U.
Men	25	65 (143)	170 (67)	3200[2]	65	0.8	12	5000	1.6	1.6	16	75	
	45	65 (143)	170 (67)	2900	65	0.8	12	5000	1.5	1.6	15	75	
	65	65 (143)	170 (67)	2600	65	0.8	12	5000	1.3	1.6	13	75	
Women	25	55 (121)	157 (62)	2300[2]	55	0.8	12	5000	1.2	1.4	12	70	
	45	55 (121)	157 (62)	2100	55	0.8	12	5000	1.1	1.4	11	70	
	65	55 (121)	157 (62)	1800	55	0.8	12	5000	1.0	1.4	10	70	
	Pregnant (3rd trimester)			Add 400	80	1.5	15	6000	1.5	2.0	15	100	400
	Lactating (850 ml. daily)			Add 1000	100	2.0	15	8000	1.5	2.5	15	150	400
Infants[3]	0-1/12[4]												
	1/12-3/12	6 (13)	60 (24)	kg.x120	kg.x3.5[3]	0.6	6	1500	0.3	0.4	3	30	400
	4/12-9/12	9 (20)	70 (28)	kg.x110	kg.x3.5[3]	0.8	6	1500	0.4	0.7	4	30	400
	10/12-1	10 (22)	75 (30)	kg.x100	kg.x3.5[3]	1.0	6	1500	0.5	0.9	5	30	400
Children ..	1-3	12 (27)	87 (34)	1200	40	1.0	7	2000	0.6	1.0	6	35	400
	4-6	18 (40)	109 (43)	1600	50	1.0	8	2500	0.8	1.2	8	50	400
	7-9	27 (59)	129 (51)	2000	60	1.0	10	3500	1.0	1.5	10	60	400
Boys	10-12	35 (78)	144 (57)	2500	70	1.2	12	4500	1.3	1.8	13	75	400
	13-15	49 (108)	163 (64)	3200	85	1.4	15	5000	1.6	2.1	16	90	400
	16-20	63 (139)	175 (69)	3800	100	1.4	15	5000	1.9	2.5	19	100	400
Girls	10-12	36 (79)	144 (57)	2300	70	1.2	12	4500	1.2	1.8	12	75	400
	13-15	49 (108)	160 (63)	2500	80	1.3	15	5000	1.3	2.0	13	80	400
	16-20	54 (120)	162 (64)	2400	75	1.3	15	5000	1.2	1.9	12	80	400

[1] In planning practical dietaries, the recommended allowances can be attained with a variety of common foods which will also provide other nutrient requirements less well known; the allowance levels are considered to cover individual variations among normal persons as they live in the United States subjected to ordinary environmental stresses. Other nutrients discussed in the text include: Carbohydrate and fat, p. 23; Water, p. 23; Sodium, potassium, and chlorine, p. 23; Phosphorus, p. 24; Copper, p. 24; Iodine, p. 24; Fluorine, p. 24; Trace elements, p. 24; Vitamin B_6 group, p. 25; Vitamin B_{12}, p. 25; Folacin, p. 26; Pantothenic acid, p. 26; Biotin, p. 26; and Vitamin K, p. 27;

[2] These calorie recommendations apply to the degree of activity for the reference man and woman described on page 3 of the text. For the urban "white-collar" worker they are probably excessive. In any case, the calorie allowance must be adjusted to the actual needs of the individual as required to achieve and maintain his desirable weight.

[3] The recommendations for infants pertain to nutrients derived primarily from cow's milk. If the milk from which the protein is derived is human milk or has been treated to render it more digestible, the allowance may be in the range of 2-3 gms. per kg. There should be no question that human milk is a desirable source of nutrients for infants even though it may not provide the levels recommended for certain nutrients. (See discussion in text.)

[4] During the first month of life, desirable allowances for many nutrients are dependent upon maturation of excretory and endocrine functions. Therefore no specific recommendations are given.

CONSIDERATION OF NUTRIENTS NOT TABULATED

Carbohydrate and Fat

Carbohydrates and fats are essential nutrients for energy, and in the pattern of the national diet of the United States they provide about 89 per cent of the calorie intake. Energy intake from carbohydrate and fat should be sufficient to avoid imposition on the utilization of protein. However, the optimum range for apportionment of carbohydrates and fats in meeting the calorie allowances is not known.

In the U.S.A. dietary, calories available from fat appear to have gradually increased from 32 to 40 per cent of the total calories in the period from 1909 to 1952.[11] The extent to which this represents a real increase in consumption is questionable because of the lack of information on wastage. Whether the increase is nutritionally desirable is also questionable. Little information is available on the human requirement for fat. While a requirement for certain unsaturated fatty acids, notably linoleic and arachidonic acids, in natural fat, has been demonstrated with experimental animals, the human need for these fatty acids is unknown. In any event, adequate amounts are readily available in ordinary diets in which fat provides as much as 20 per cent of the total calories. The association of dietary fat with obesity and degenerative disease remains to be elucidated in relation to total calorie intake.

The relative nutritional merits of sugars and starches as compared with the more complex polysaccharides are difficult to assess. Differences in utilization of nutrients in synthetic diets with different carbohydrates have been noted in experimental animals, but the applicability to human nutrition is unknown. Likewise, little is known as to the importance of the indigestible fractions of plant food products in relation to intestinal function. Recommended allowances for carbohydrates and fats cannot be formulated as yet.

Water

A suitable allowance of water for adults is 2.5 liters daily in most instances. An ordinary standard is one milliliter for each calorie of food. Much of this quantity is contained in prepared foods. Water should be allowed *ad libitum*. Sensations of thirst usually serve as adequate guides to intake, except for infants and sick persons. Under conditions of extreme heat or excessive sweating, the sensation of thirst may not keep pace with the actual water requirements, and forced intakes up to one liter per hour may be indicated for a short time.

Sodium, Potassium, and Chlorine

These three elements are indispensable dietary constituents and function prominently in the maintenance of water balance. Potassium is especially abundant in both plant and animal tissues and does not need consideration as a dietary adjunct.

The average intake of sodium chloride (salt) for the normal adult is 7 to 15 grams daily. This includes sodium and chlorides contained in foods as well as those added to food as salt. It more than meets the normal requirements. The requirement for sodium chloride is increased by environmental and climatic conditions associated with increased sweating. Under unusual conditions, such as

doing heavy work in a hot climate, 10 to 15 grams daily, or even more, may be required with meals and in drinking water. However, after acclimatization to heat the sodium content of sweat is greatly reduced and the allowance for salt can be near to normal.

Phosphorus

In the original table no allowances were formulated for phosphorus because of the view that dietary deficiencies of phosphorus are uncommon and that diets which are adequate in other respects, particularly in calcium, are ordinarily adequate in phosphorus. In preparation for the 1945 revision, a large amount of published and unpublished data from balance studies was brought together and evaluated. The evidence indicates that the phosphorus allowances should be at least equal to those for calcium in the diets of children and of women during the latter part of pregnancy and during lactation. For other adults the phosphorus allowances should be approximately one and one-half times those for calcium. When the calories are obtained largely from cereals, computation of the total phosphorus intake may be misleading because phytin phosphorus may be poorly utilized unless the supply of vitamin D is adequate. In general, it is safe to assume that if the calcium and protein needs are met through common foods, the phosphorus requirement also will be covered, because the common foods richest in calcium and protein are also the best sources of phosphorus.

Copper

The requirement for copper for adults is about 1 to 2 milligrams daily. Infants and children require approximately 0.05 milligrams for each kilogram of body weight. The requirement for copper is approximately one-tenth that for iron. A good diet normally will supply sufficient copper.

Iodine

The requirement for iodine is small, probably about 0.002 to 0.004 milligrams daily for each kilogram of body weight, or a total of 0.15 to 0.30 milligrams daily for the adult. This need is met by the regular use of iodized salt; its use is especially important in *adolescence* and *pregnancy.*

Fluorine

Small amounts of fluoride are generally present in plant and animal tissues, especially in bones and teeth. No conclusive evidence that fluorides have an essential function in nutrition or metabolism has been adduced. However, extensive evidence indicates that during tooth development a controlled intake of fluoride, such as is provided by drinking water containing about 1 part per million, results in substantial protection against dental caries. This practice is recognized as an important public health measure.

Trace Elements

Certain trace elements (also referred to as micro-, rare, minor, and oligo-elements or micronutrients) commonly found qualitatively in biological organisms have functional significance most frequently associated with enzyme systems. Other than that the amounts are exceedingly small, relatively little is known about the quantitative levels necessary for essential physiological function of these elements

in human nutrition, and less is known about desirable dietary levels. Sufficient amounts are undoubtedly present in ordinary diets. The possibility of antagonisms between metals and of intoxication must be considered along with any attempt to correct suspected deficiencies of the trace elements.[16] Among those not noted elsewhere which presumptive evidence would indicate to be essential, mention may be made of cobalt, magnesium, manganese, molybdenum, and zinc.

Vitamin B_6 Group

Vitamin B_6 is a complex of three closely related chemical compounds: pyridoxine, pyridoxal, and pyridoxamine. Pyridoxal phosphate has been shown to be the active coenzyme form of this complex.[166] Vitamin B_6 occurs in animal products largely as pyridoxal and pyridoxamine, in plant products as pyridoxine.[172] In animals, the three forms are equally active when given separately from the diet, but pyridoxine is the most active when given with food.[178] In the rat, vitamin B_6 is synthesized by intestinal organisms[163] and may be available to the animal for an appreciable part of metabolic needs. Whether this is true of the human being has not yet been established.

Several common nutrients increase the need for vitamin B_6 in animals. Among these are methionine,[162] protein, [161] linseed oil,[168] and sucrose.[174] On the other hand, certain substances such as choline, aureomycin, essential fatty acids, biotin, and pantothenic acid[176] seem to decrease the requirement. Certain biochemical functions of vitamin B_6 have been reported.[160, 164, 165]

The need for and function of vitamin B_6 in human nutrition has been demonstrated only recently,[171, 175, 179, 181] though there are several earlier indications of its essentiality.[165, 167, 177, 180] Rough estimates of human vitamin B_6 requirements may be made from certain animal experiments[173] and tests with humans.[171] Balance studies[169, 170] are questionable for this purpose, since no evidence is available on the effect of intestinal synthesis. The evidence available indicates that the daily intake of vitamin B_6 should be from 1 to 2 milligrams, an amount which is readily provided by ordinary mixed diets.

Vitamin B_{12}

Vitamin B_{12} has been found to be an essential nutrient in many animal species and its metabolic functions have been the subject of wide investigation.[187] In man, observations on the hemopoietic activity of vitamin B_{12} support the suggestion[193] that approximately 1 microgram daily parenterally will allow replacement of the lack in pernicious anemia. Present information is not sufficient to permit extrapolation of this estimate to the dietary requirement of healthy adults.

The provision of supplementary vitamin B_{12} to premature infants has not resulted in growth stimulation.[186, 188] It appears probable that normal infants being fed on cow's milk formulas or on breast milk receive sufficient vitamin B_{12} to meet their needs.[189]

Some workers have reported data interpreted as indicating a growth stimulation in children.[184] Data from other studies[183, 190] fail to provide evidence of effectiveness of vitamin B_{12}. These investigations are of varying quality, but each is subject to one or more of the following limitations: smallness of samples, failure to match age and sex grouping in control and supplemented groups, failure to eliminate psychologic factors, inadequate information concerning dietaries of the in-

dividuals studied, and absence of information on the vitamin B_{12} content of the foods consumed.[182] The data available are insufficient as a basis for a recommended dietary allowance of vitamin B_{12}.

Folacin

Since the 1948 revision of the Recommended Dietary Allowances little additional information bearing directly upon the dietary intake of the pteroylglutamates or the quantitative estimates of needs has been reported. A useful compilation of the folic acid activity in foods[191] has appeared. Unfortunately, methods for the estimation of the individual members of the folacin group of substances have not been widely applied, and the microbiological procedures sometimes present difficulties because of the presence of stimulants other than folacin.[192] Hence, dependable values on the dietary intake of folacin under a variety of conditions are not available.

In several instances therapeutic responses to folic acid following administration of 1 milligram daily are recorded.[185] Woodruff, Peterson, and Darby[194] have recorded effective therapeutic response of two cases of megaloblastic anemia in infancy to oral doses of 500 and 200 micrograms per day, respectively. These low therapeutically effective doses are in agreement with an estimate of the human requirement of this factor made by extrapolating the results of studies on monkeys, chickens, and turkeys on a caloric basis. It seems probable that dietary intakes of the order of less than a milligram per day can be expected to cover any nutritional needs for folic acid activity. The actual requirement or allowance cannot be set at this time.

Pantothenic Acid

Pantothenic acid is a part of coenzyme A which mediates acetylation and many other acylation reactions. It is intimately involved in the aerobic utilization of carbohydrates, in the synthesis and degradation of fatty acids, sterols, steroid hormones, etc., and in a number of other processes. Pantothenic acid deficiency has been induced in every animal in which it has been seriously attempted and always results in severe symptoms and eventual death. It is a practical certainty that pantothenic acid is required in human nutrition. It has been reported to improve the reactions of young men to stress[196] and to relieve the burning feet syndrome.[195] The amount of pantothenic acid consumed daily with 2500 calories of good diet is approximately 10 milligrams.[198]

Biotin

The exact mode of functioning of biotin in enzymatic systems has not been elucidated. It is, however, evident that the vitamin is required directly or indirectly for several reactions in which carbon dioxide is fixed in mammalian and bacterial systems. In the latter systems, evidence for its participation in the synthesis of unsaturated fatty acids also is strong. Intestinal synthesis of this vitamin is extensive and tends to prevent the development of deficiency. However, dietary deficiencies are demonstrable in rapidly growing animals following the administration of sulfonamides. Biotin deficiency symptoms have been induced in human beings by feeding raw egg white and have been alleviated by a biotin concentrate. Hence its need by human beings may be said to have been directly demonstrated.[197]

Vitamin K

The amount of vitamin K required for maintenance of a normal prothrombin level in the blood is easily provided when an average diet is ingested. However, special attention to this vitamin is desirable in the latter part of pregnancy and for the newborn infant. Pregnant women usually have normal amounts of prothrombin in the blood, but many newborn infants have abormally small amounts. Although little relation seems to exist between the amount of prothrombin in the blood of the mother and that of the infant at birth, the amount of vitamin K received by the mother is reflected quickly in the amount of prothrombin in the blood of her infant *in utero*. Seldom does the mother have enough vitamin K without supplement to prevent an important decrease in the prothrombin level of the blood of her infant during the first days after birth.

The customary concept that regulation of the amount of prothrombin is the only function of vitamin K has been brought into question and its implication in brain hemorrhage and damage has been reported.[199] In view of the very large number of babies with intracranial damage at birth and the possible relationship of these lesions to vitamin K deficiency, it is suggested that a daily oral dose of 1 milligram of vitamin K be given to pregnant women during the last month of pregnancy. If the mother has been treated in this manner, the newborn infant needs no supplement of vitamin K during the short period preceding ingestion of food.

When the vitamin K status of the mother has been unsatisfactory or is unknown at the time of labor, it is desirable that this vitamin be given to the mother before the birth of the baby, or to the baby immediately after birth, preferably the former. It has been demonstrated that the prothrombin level of the baby is higher in the first days after birth if vitamin K is given to the mother before delivery than if it is given to the baby at birth. A suitable amount for the mother preceding delivery is 1 milligram administered parenterally; this amount will stabilize the prothrombin level of the infant until food is taken. A suitable amount for the infant after birth is 1 milligram for a single dose. In fact it has been shown that a single dose of 10 to 20 micrograms is adequate to cover the first 5 days. The daily requirement of the infant is approximately 1 microgram.[200]

GENERAL DISCUSSION

The recommended allowances for adults are given in terms of a reference man and reference woman as described in the section on calories. Adjustment should be made for persons who differ from the standard in body size, age, or physical activity. Allowances for infants and children are given for age groups and, after the age of ten, for boys and girls separately, since the growth curves and levels of activity differ significantly from about this age. Allowances are based on the needs for the middle year in each group and are for normal activity and for the weights indicated in the table. As with adults, adjustments should be made for children who differ in size and activity from the standard.

The breakdown into three periods of infancy is an innovation of this revision of the Recommended Dietary Allowances. Recognition is given to the differences in the recommended allowances for infants and the nutrient levels supposedly provided by maternal lactation. References [7] and [13] may be consulted for further detail in this regard.

The recommended allowance values of the table are for nutrients in foods as consumed and do not take into consideration prior losses in storage, cooking, and serving. Provision should be made for these losses in planning practical dietaries. The allowances do provide for possible incomplete availability or absorption of certain nutrients, such as iron and carotene.

The allowances are intended to serve as a guide for planning adequate diets for substantially all normal healthy persons in the United States. It is recognized that the biological normal consists of a range of values. The allowances are designed to provide for requirements in the high normal range as well as for the average.

The allowances are expected to cover short-term needs and also to maintain good nutrition for the life span as a whole, although little is known of long-term requirements. There is evidence from studies on animals that benefits accrue during a lifetime when the intake of certain nutrients is considerably higher than minimal need. It should be emphasized that the allowances apply only to persons in good health. This is particularly true for women during pregnancy. Requirements vary greatly in disease; in febrile illnesses and other hypermetabolic states, the need for certain nutrients may be markedly increased, while in diseases of the gastrointestinal tract, absorption of nutrients may be seriously impaired.

When the recommended allowances are used to estimate the per capita needs of population groups, the allowances should be weighted by the composition of the population according to categories and ages. In times of diminished food supply, it may be impossible to meet these recommendations. In such circumstances it is essential to distinguish between standards based on good nutrition for all and more immediate consumption goals based on practical possibilities.

The recommended allowances for the various nutrients, with the exception of vitamin D, can be obtained through a good diet of common foods. Fortunately, good nutrition may be provided by many different combinations of foods. The dietary pattern of seven basic food groups presented in the National Food Guide[14] has been widely used in the United States as an aid for selection of adequate diets. It is obvious that this guide serves only as a rough approximation of nutrient

intake. The size of servings will vary greatly and there is marked variation in the nutritive value of foods which have been grouped together. Consistently poor choice of foods from each of the seven groups can result in an inadequate diet.

Some foods are important because of their unique nutritional contribution and cannot easily be replaced.[1] Milk is an important source of protein, calcium, riboflavin, and other nutrients. Citrus fruits and tomatoes are outstanding sources of vitamin C, although significant quotas may be obtained from other fruits, potatoes, and most leafy, green, and yellow vegetables, in spite of losses during food preparation in the latter groups. For some population groups, such as pregnant and lactating women, consistent selection of foods of high nutritive quality is essential or it will be difficult to meet needs without an excess of calories. These and similar problems will arise with the use of any type of food guide.

Quantitative guides for the selection of an adequate diet at different food cost levels have been published by various national, state, and local groups. Those available from the U. S. Department of Agriculture are listed in the references.[6, 15] A commendable booklet entitled "A Balanced Diet" is available from the Nutrition Foundation, Inc.[2] A comprehensive tabulation of food composition has been published by the U. S. Department of Agriculture.[17]

Again the point must be emphasized that foods selected to provide the specific nutrients for which quantitative allowances have been recommended are most likely to provide also the other essential nutrients for which quantitative requirements have not been adequately determined.

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